Flood Mapping from NOAA operational satellites

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NOAA

Satellite and Information Service

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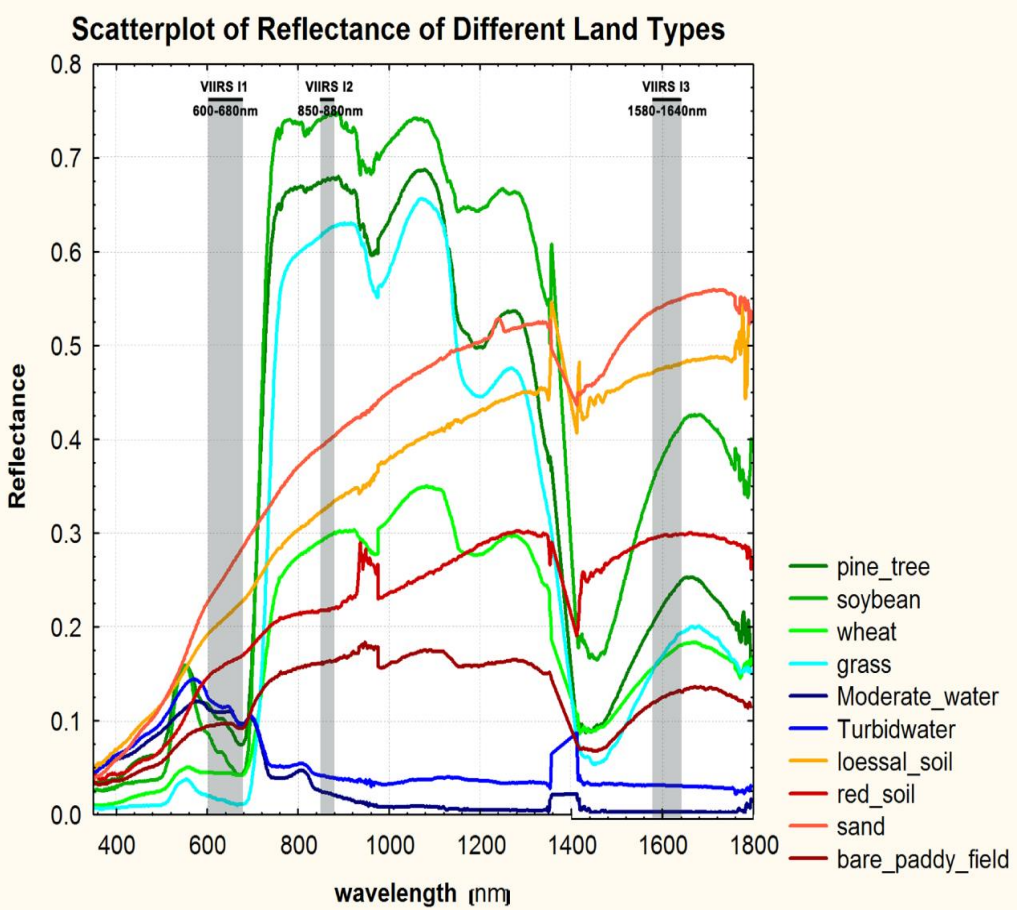
Flood Mapping from NOAA operational Satellites

- Flood events have the highest frequency and most damaging impact of all natural disasters.
- New operational weather satellites such as JPSS and GOES-R for the very first time have the spectral bands for inundation mapping and large geographic and temporal coverage.
- These satellites have real-time distribution capabilities allowing fast generation and utilization of disaster products for critical decision making.
- The operational polar satellites have direct broadcast and the geostationary satellites have direct broadcast, rebroadcast, and/or cloud services for immediate access to data.

Method – Supra-veg/bare land flood detection



- Decision-tree approach using the following variables: R_{Vis}, R_{NIR}, R_{SWIR}, NDVI, NDSI and NDWI based on different land cover types under different solar zenith angles.

$$\mathrm{NDVI} = \frac{R_{NIR} - R_{Vis}}{R_{NIR} + R_{Vis}}$$

$$\mathrm{NDSI} = \frac{R_{Vis} - R_{SWIR}}{R_{Vis} + R_{SWIR}}$$

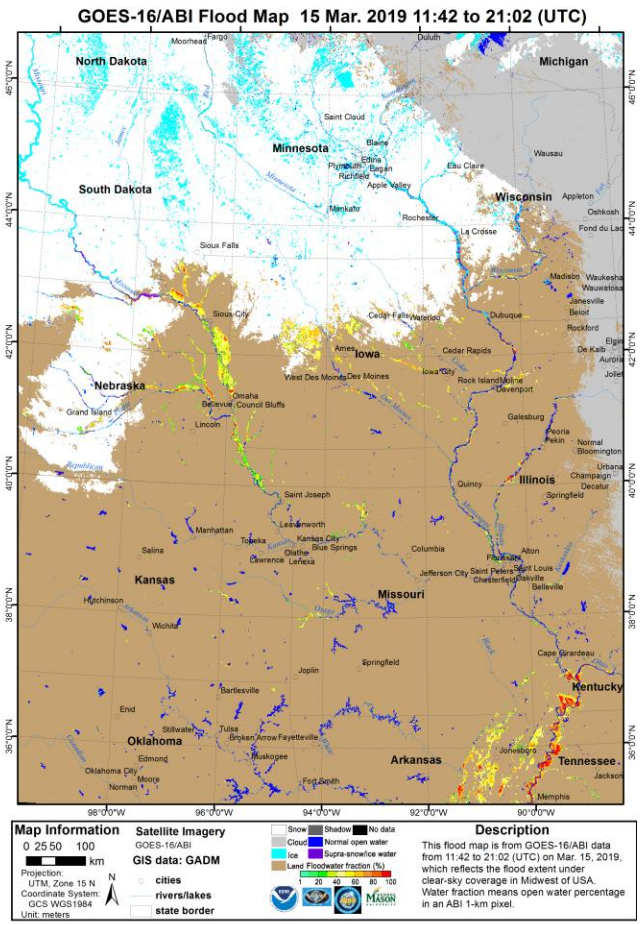
$$\mathrm{NDWI} = \frac{R_{NIR} - R_{SWIR}}{R_{NIR} + R_{SWIR}}$$

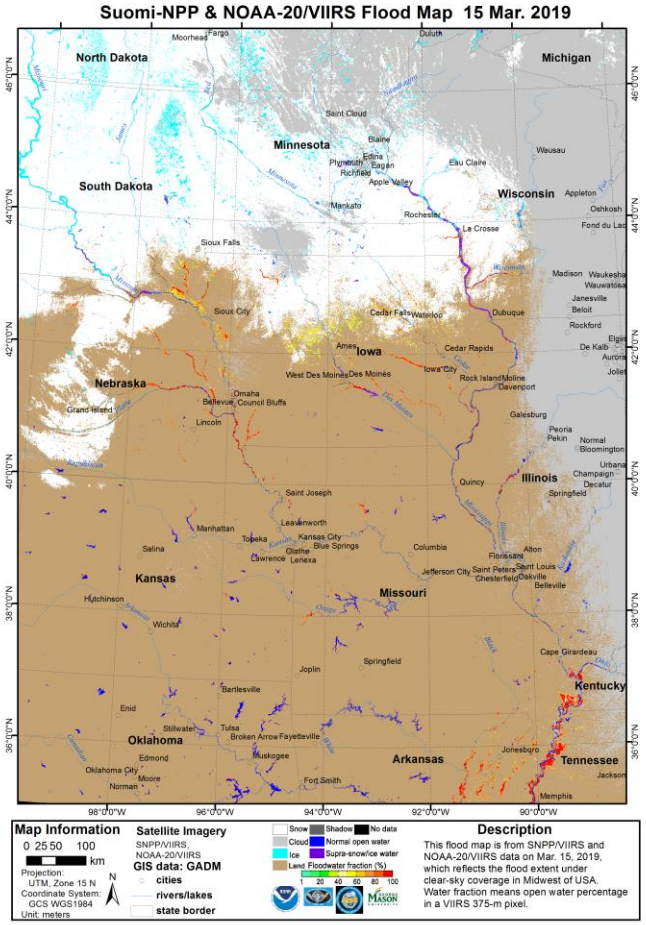
$$R = \sum_{i=1}^{n} f_i * R_i \qquad f_w = \frac{R_{ch\_land} - R_{ch\_mix}}{R_{ch\_land} - R_{ch\_water}}$$

GEO and LEO Interplay

GOES-16 ABI 1 km flood map will provide early situational awareness;

The higher spatial resolution JPSS VIIRS (375 meters) will provide finer more accurate details, however the product is not available until 3 – 4 pm (daylight time) – JPSS is an afternoon satellite





GEO and LEO Interplay - ZOOMED IN

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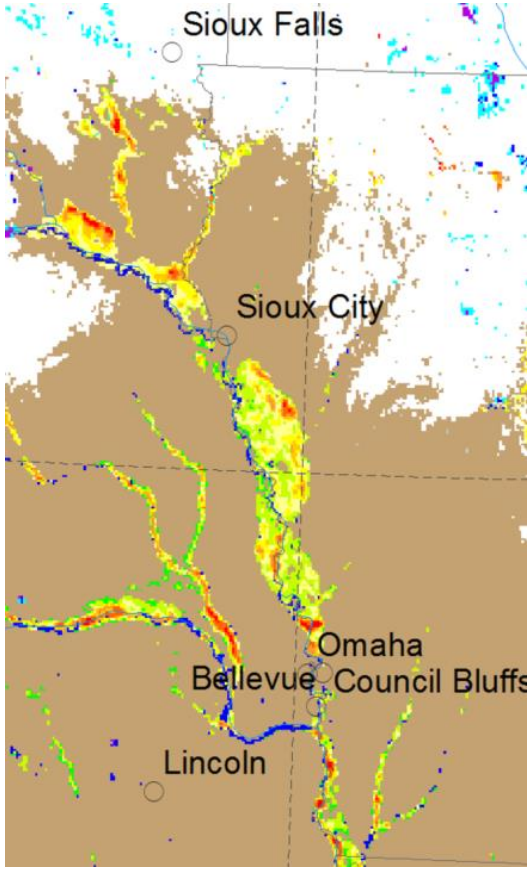
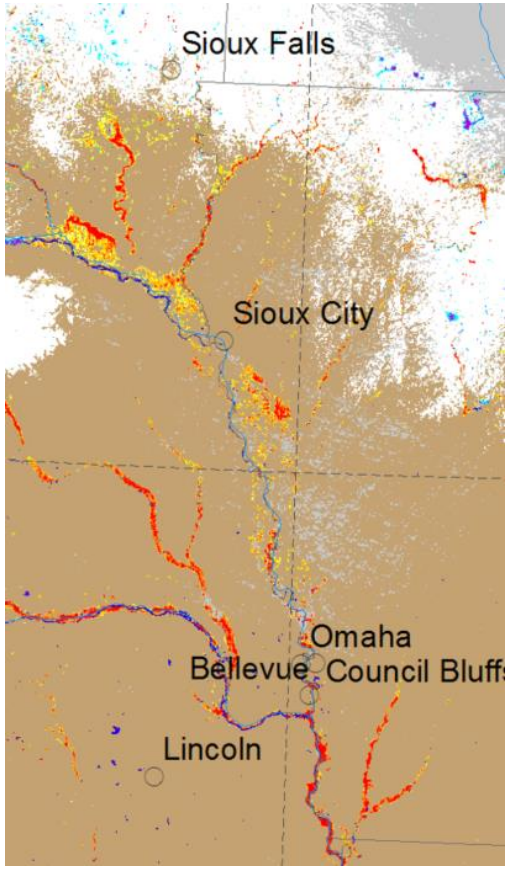
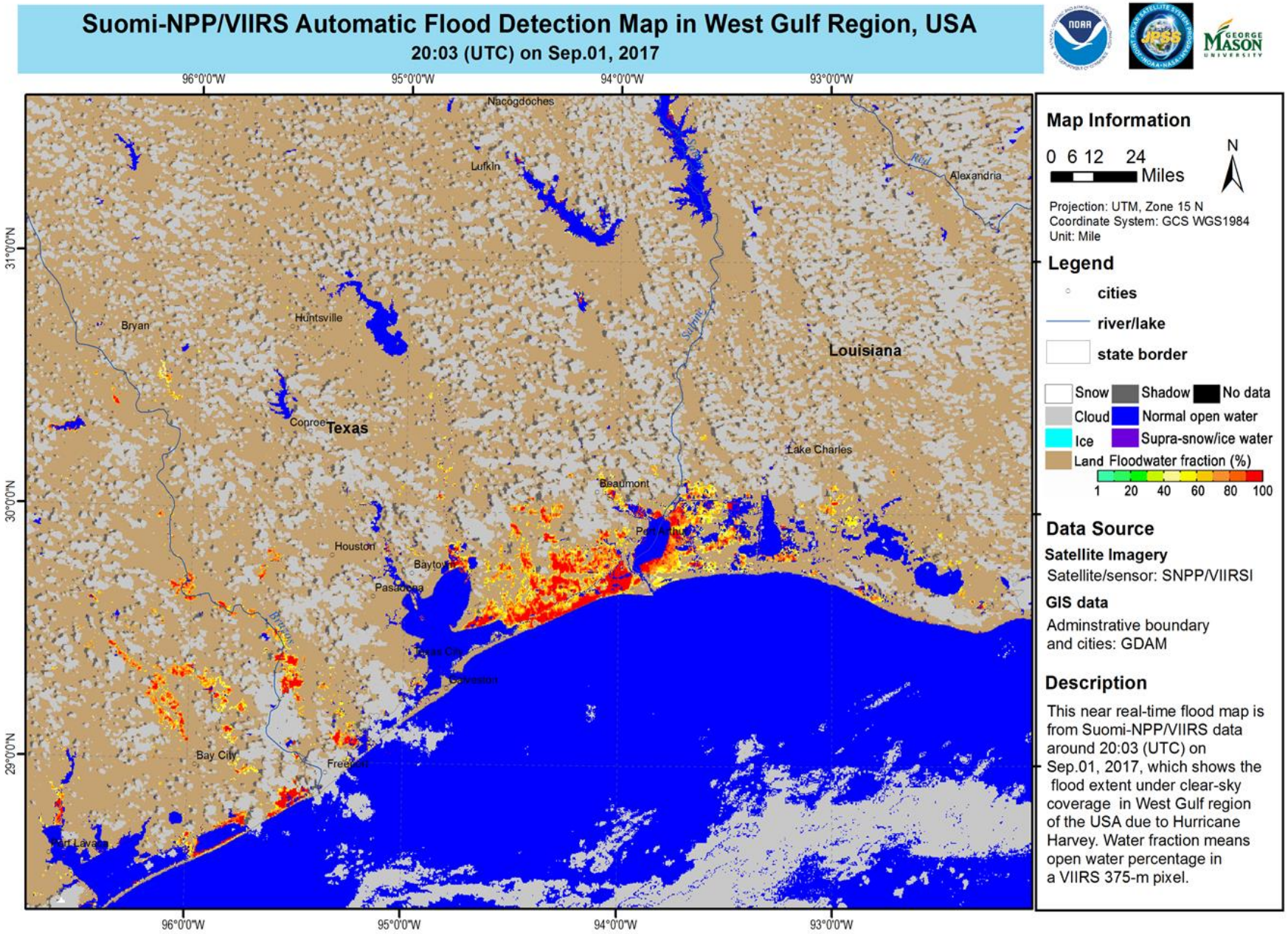


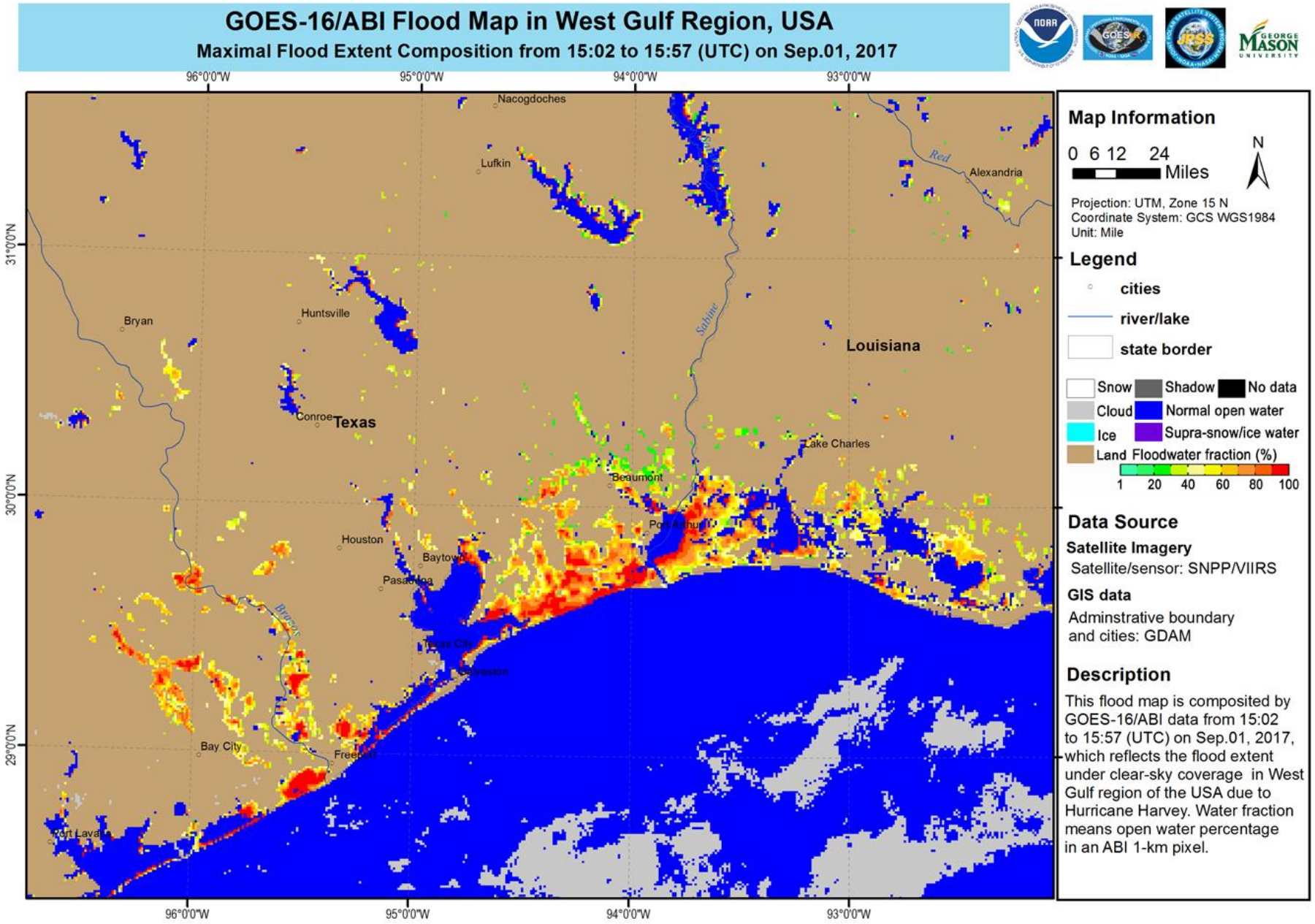


VIIRS can be prone to clouds

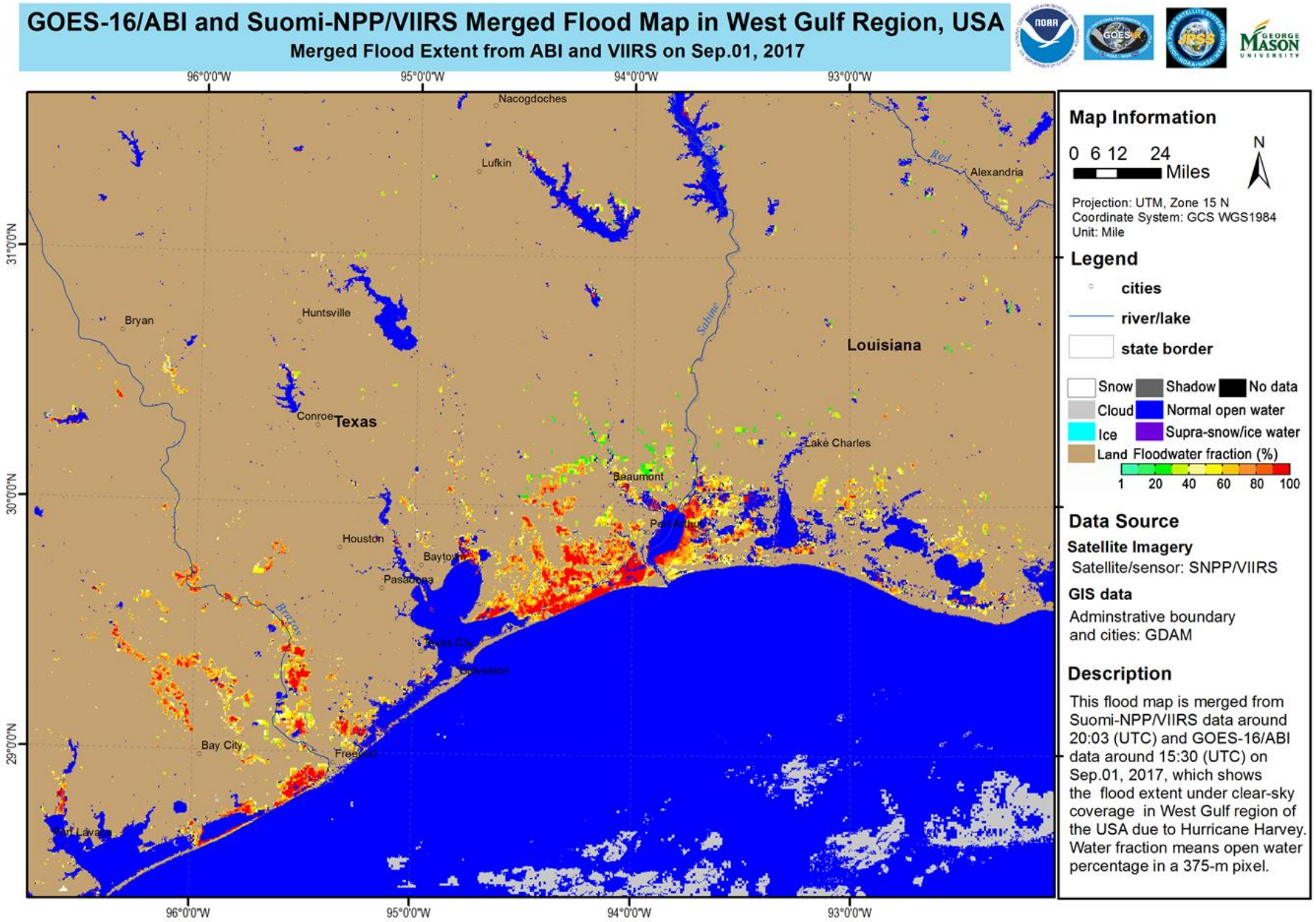


Since GOES ABI has a temporal refresh of every 5 minutes, we can aggregate clear pixels to remove the clouds

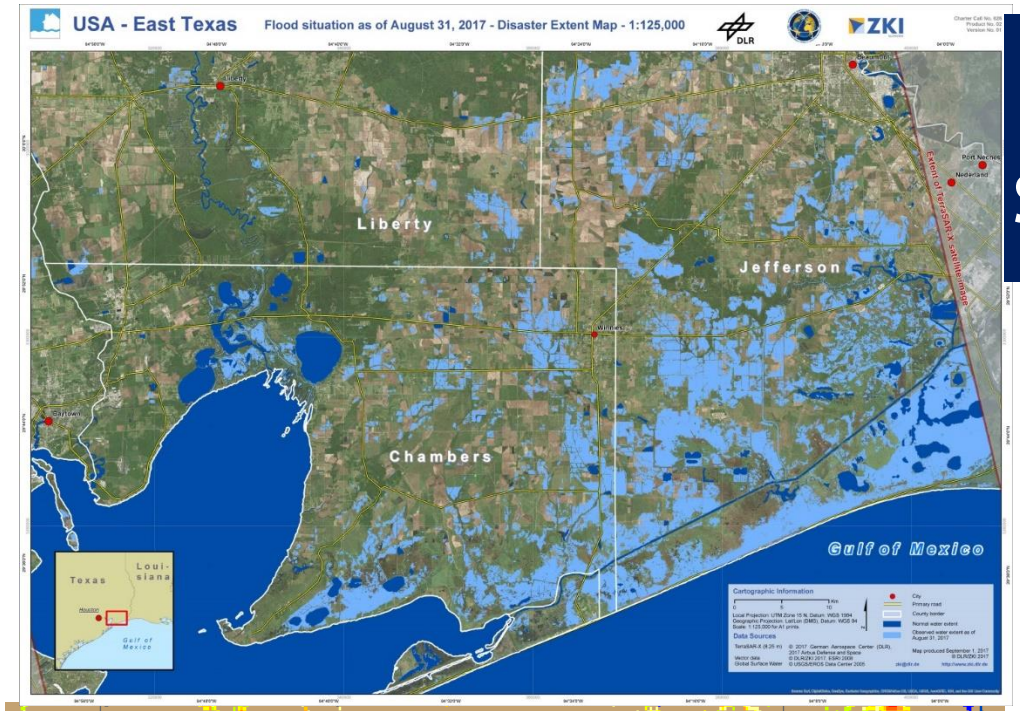
This example is for a 55-minute aggregations

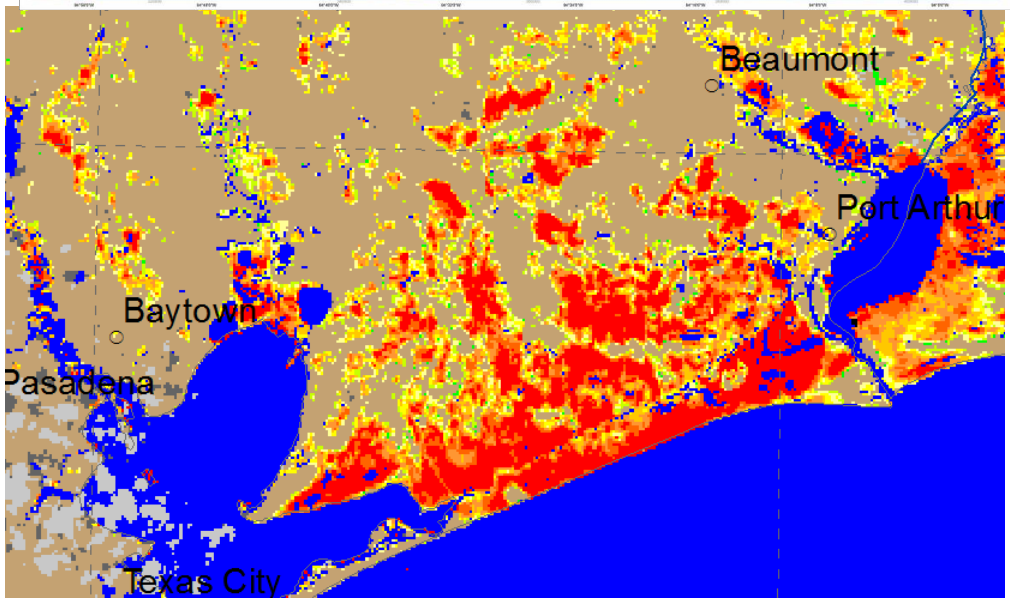


Final process is to merge both the GOES and JPSS products to provide the optimal product



Comparison with Sentinel-1 Flood Product





Sentinel-1 flood map on Aug. 31, 2017 in West Gulf region, USA

Advantage: Can see through clouds

Disadvantage: Limited coverage

VIIRS 375-m flood map in the similar region with Sentinel-1 Aug. 31, 2017

Advantage: Areal coverage

Disadvantage: Can not see through clouds, limited resolution

NOAA Automated Flood Mapping Response System

JPSS Products

VIIRS Flood Detection Map Quick Guide

What is the VIIRS Flood Detection Map?

The VIIRS Flood Detection Map, which is called VIIRS NOAA&GMU Flood Version 1.0 (VNG Flood V1.0), is a satellite-based flood extent product derived from daytime Suomi-NPP/VIIRS imagery with solar zenith angles less than 85 degrees. Its spatial resolution is 375 meters. Flood extent is represented in floodwater fractions (water fraction means percentage of water extent in a VIIRS 375-m pixel).

What is the VIIRS Flood Detection Map algorithm?

VIIRS Flood Detection includes a series of algorithms: a water detection algorithm based on decision-tree approach, a geometry-based cloud shadow removal algorithm, an object-based terrain shadow removal algorithm, a minor flood detection based on change detection algorithm and a water fraction retrieval algorithm with dynamic nearest neighboring searching method. Floodwater is determined by comparing the detected water against a water reference map derived from MODIS global 250-m water mask (MOD44W) and water layer in the 30-m National Land Cover Dataset.

Which spectral bands make up the algorithm?

The spectral bands used in the algorithms are Suomi-NPP/VIIRS Imager bands 1 (600~680 nm), 2 (850~880 nm), 3 (1580~1640 nm) and 5 (1050~1240 nm) with 375-m nominal resolution and I-band terrain-corrected geolocation data (i.e. GITCO) including longitude, latitude, solar zenith angles, solar azimuth angles, sensor zenith angles and sensor azimuth angles.

Data latency of VIIRS Flood Detection Map data?

The VIIRS flood detection system is running routinely at SSEC/UW-Madison and GINA/UAF using direct broadcasting VIIRS data. VIIRS near real-time flood maps have about a 1-hour latency after VIIRS daytime overpasses are received. Generally, VIIRS flood maps are available around 13:30pm local time in the lower 48 states - more frequent coverage is achieved in Alaska.

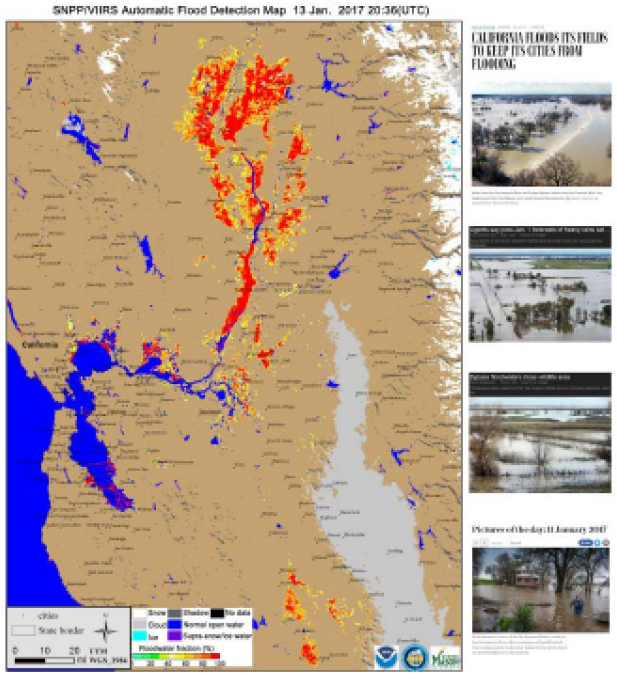
Available in AWIPS-II for National Weather Service Forecasters

Near real-time flood maps are distributed via the Unidata Local Data Manager (LDM) in AWIPS-II. The instruction document is here:
https://drive.google.com/open?id=1mEDFEXzIXCTEGXfb_coLGm2fkONdsPI9G0hj7xS2AYM
Please contact Jay Hoffman (jay.hoffman@ssec.wisc.edu) for any questions related to AWIPS-II.
Additionally, the latest 30-day flood maps are also available in SSEC's Real Earth:
CONUS: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-US
NERFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-NE
NCRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-NC
MBRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-MB

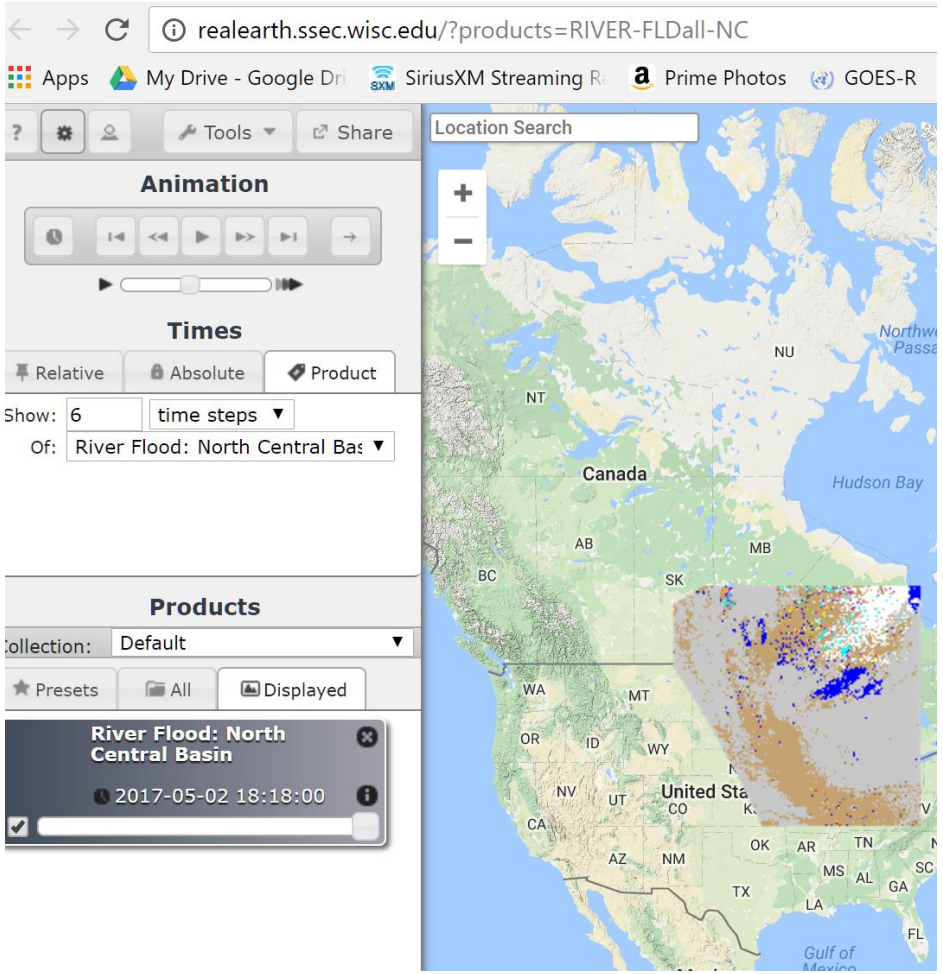
APRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-AP
WGRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-WG
SERFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-SE
NWRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-SE
CNRFC: http://realearth.ssec.wisc.edu/?products=RIVER-FLDall-SW

Examples of the VIIRS Flood Detection Map

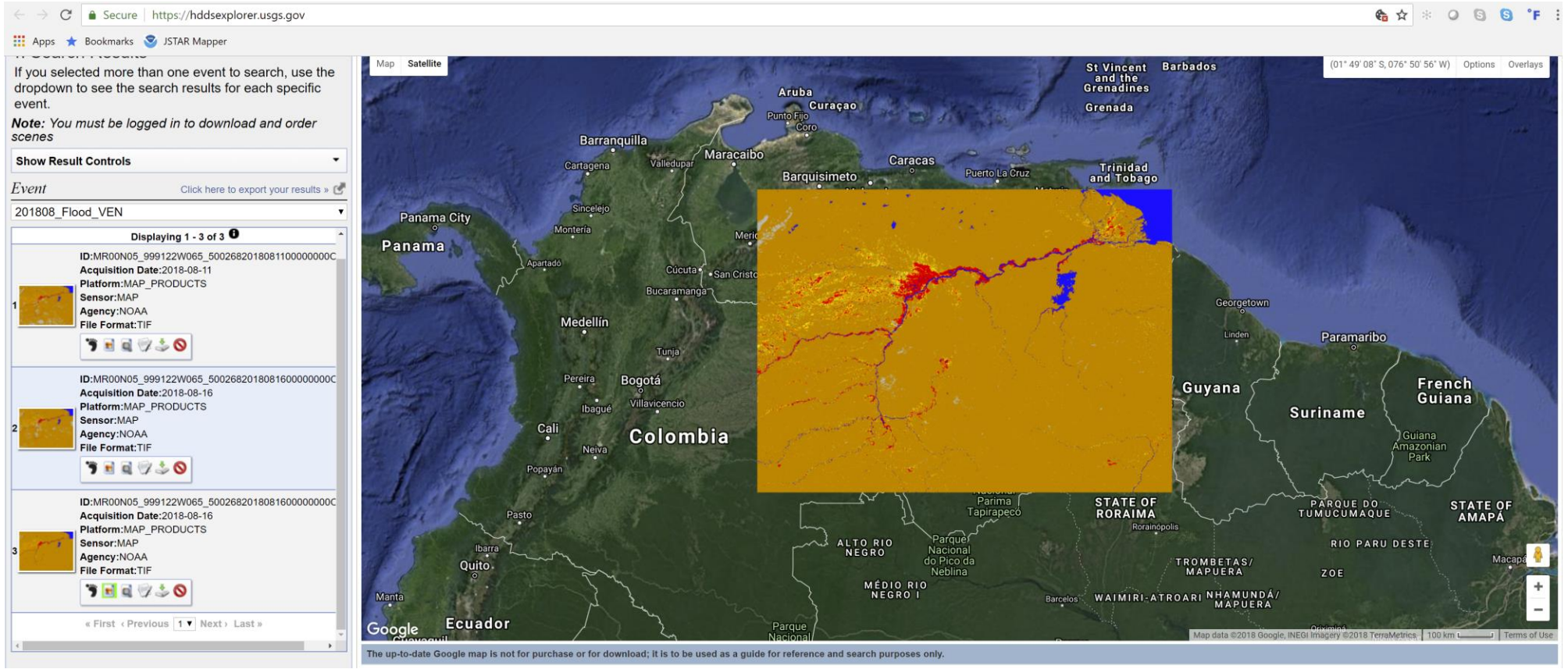
There are eight pixel types in the VIIRS flood map: cloud (grey), snow cover (white), river/lake ice cover (cyan), shadows (dark grey), clear-sky land (brown), normal open water (blue), supra-snow/ice water or mixed ice & water (purple), and supra-veg/bare soil flooding water fractions (light cyan to red). Below are three examples of the VIIRS Flood Maps.



An example of VIIRS flood map (left) and pictures (right) of flooding in Northern California.



Support International Charter Disaster Activations



Summary

- **NOAA Flood Maps**
  - Product(s) use JPSS VIIRS and GOES-R ABI imagers.
  - Very low latency
  - Available to NWS via AWIPS system.
  - Direct data feed to FEMA
  - Public access through RealEarth (UW) website